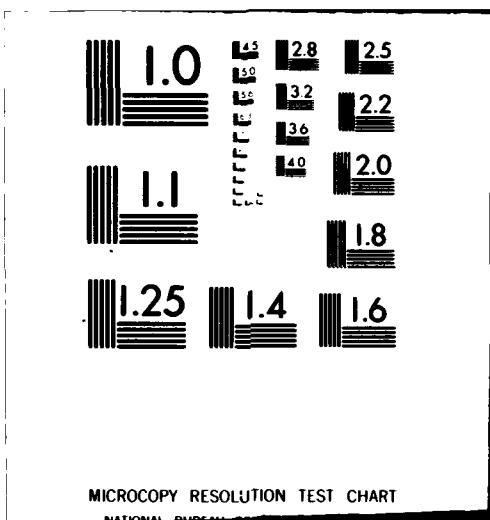


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MASSACHUSETTS INSTITUTE OF TECHNOLOGY
LINCOLN LABORATORY

ADVANCED ELECTRONIC TECHNOLOGY

QUARTERLY TECHNICAL SUMMARY REPORT
TO THE
AIR FORCE SYSTEMS COMMAND

1 NOVEMBER 1979 - 31 JANUARY 1980

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INTRODUCTION

This Quarterly Technical Summary covers the period 1 November 1979 through 31 January 1980. It consolidates the reports of Division 2 (Data Systems) and Division 8 (Solid State) on the Advanced Electronic Technology Program.

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DATA SYSTEMS
DIVISION 2

INTRODUCTION

This section of the report reviews progress during the period 1 November 1979 through 31 January 1980 on Data Systems. Separate reports describing other work of Division 2 are issued for the following programs:

Seismic Discrimination	DARPA/NMRO
Distributed Sensor Networks	DARPA/IPTO
Education Technology	Bureau of Mines
Network Speech Systems Technology	OSD-DCA
Digital Voice Processing	AF/ESD
JTIDS Speech Processing	AF/ESD
Packet Speech Systems Technology	DARPA/IPTO
Radar Signal Processing Technology	ARMY/BMDATC
Restructurable VLSI Technology	DARPA/IPTO
Multi-Dimensional Signal Processing	AF/RADC

A. J. McLaughlin
Head, Division 2
A. V. Oppenheim
Associate Head
T. Bially
Associate Head

DIGITAL INTEGRATED CIRCUITS
GROUP 23

I. INTRODUCTION

The first 64K MNOS memory chips with CMOS digit decoding exhibited lower parasitic noise than the earlier design. Several improved processing methods are being investigated.

II. MNOS MEMORY

The first operable 64K MNOS memory wafers with CMOS digit decoding on sapphire substrates were fabricated. The digit decode circuit connects the selected digit line to the select bus through an n-channel depletion mode transistor and unselected lines are connected to the unselect bus through a p-channel enhancement mode transistor. The dynamic pulldown of unselected digit lines is designed to reduce parasitic-coupled selection noise in the sense signal as compared to arrays with pulldown resistors. A 64K array was operated and parasitic noise was substantially reduced but not as much as expected, probably because second-level metal contact resistance on this wafer is higher than normal. The signal-to-random noise ratio at the output of the off-chip sense amplifier was 32 dB.

Word and digit lines in this array are on 10- μm centers except on two edges where lines are on 5- μm centers. Signals in the quadruple density corner were smaller by about a factor of 4, as expected.

III. RESTRUCTURABLE LOGIC DEVICES

The programmable logic array test chip design has been finished and the first four reticles have been fabricated.

A new process for self-aligned drain-source protection of p-channel metal gate MNOS transistors has been developed. The transistors have the high channel conductance of non-protected devices and the high diode breakdown voltage of conventional protected devices. Tests show that processing should be easy to control. These transistors may be useful as programmable links in restructurable VLSI.

IV. PROCESSING DEVELOPMENT

A. Bipolar Transistors

A processing schedule has been defined using ion implantation to predeposit the transistor inactive base and polysilicon resistor regions using photoresist as a mask thus allowing the poly-ox process to become an all-implanted technology.

A diagnostic technique has been developed where individual processes are deleted to identify the contribution of these processes to final emitter-collector leakage. Initial runs have shown a substantial fraction of leakage to be due not to the transistor processing but rather to initial processing such as buried collector formation and epi-poly growth. Further, the small portion of the leakage that is attributable to transistor fabrication has been shown to be proportional to the emitter-base-collector periphery length along the sidewall isolation oxide.

B. Dielectric Isolation

A new form of dielectric isolation has been proposed which combines features of the neon-damage isolation and the poly-ox process. Conceptually, the new form can be envisioned by replacing the spoiler oxide and polysilicon by a layer of silicon damaged by neon implantation. Possible advantages of this isolation are a relaxation of the critical conditions necessary for simultaneous epi-poly growth and a more planar surface.

C. Static Induction Transistors

Static induction (or vertical junction field effect) transistors may be very readily made using fabrication processes developed for bipolar technology. Using an existing mask set for a bipolar transistor with a 1- μm emitter and minor processing modifications, a run of operable test transistors has been made and further runs are in process to explore the high-frequency behavior of such devices.

D. Ion-Implant Masking

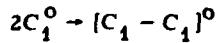
Preliminary investigation of polyimide as an ion-implant masking material has shown that it has the same stopping capability as the positive photoresist currently being used, but does not flow or otherwise degrade as resist does when heated during the implant process. Thus, finer implant mask geometries are feasible, as is higher wafer throughput, since the polyimide implant mask can tolerate the higher temperatures resulting from higher current-shorter duration implants.

E. Laser Annealing

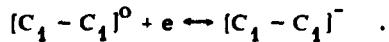
A 0.6- μm layer of amorphous silicon doped with phosphorus was grown on a 1- μm layer of thermal oxide. The amorphous silicon was etched into 0.4- \times 10-mil lines. The silicon lines were melted by traversing a laser spot in the long direction. Then a gate oxide was grown on each resistor and a metal gate formed on top. Measurements showed mobility within a factor of 2 of the expected bulk value and lifetimes of the order of 0.1 msec; these are comparable to values usually found in silicon-on-sapphire.

V. PEROXY LINKAGE DEFECTS IN SiO_2

In addition to the valence alternation pair (VAP) defects in a- SiO_2 , C_3^+ , an oxygen atom bonded to three silicon atoms and C_1^- , an oxygen atom bonded to one silicon atom, a new type of defect has recently been reported in the literature. At high densities of defect states due to neutron irradiation of the a- SiO_2 peroxy linkages have been detected by both ESR and photoluminescent experiments. It is proposed that these arise as a result of the reaction between two C_1^0 states, i.e.,



which is a peroxy linkage. In conformation with experiment these defects can trap only one electron, i.e.,



VI. FACILITIES

A three-tube furnace system capable of processing 2- to 3-in. wafers was installed and put into use during this period. The furnace is equipped with one low-pressure chemical vapor deposition (LPCVD) system to deposit undoped polysilicon and a second LPCVD system to deposit silicon nitride. The third tube is equipped for annealing and oxidation processing.

A GCA 4800 Direct Step on Wafer alignment and exposure system has been installed and checked out. It has demonstrated a considerably greater exposure time latitude for good 1.5- to 2- μ m features than the contact aligner. New Calma software has been installed for generation of output for the GCA 3600F pattern generator. All the new conventions and procedures for designing masks to be made on the 3600F and used on the 4800 have been documented.

COMPUTER SYSTEMS
GROUP 28

During the quarter the Laboratory made an award to the Amdahl Corporation for the installation of a 470/V7 to replace the present IBM 370/168. The new system, selected from among competitive bids, will be operational about 1 April 1980, and will provide twice the power of the old system. The V7 also has twelve data channels which will relieve some device contention and address limitations, particularly those involving user terminals.

Because the Amdahl 470 is both hardware and software compatible with the IBM 370/168, the installation will amount to a system upgrade. This means that the central processor, channels, and main memory will be replaced while the operating systems, user programs, and all ancillary equipment will continue in service unchanged. Configuration and site planning are in progress.

As previously reported, the Information International COMp 80 CRT plotter is providing hard copy and film output for Laboratory programs. A new feature being provided on a limited basis is high-quality text output using the Times Roman Graphics Art font. Recent rapid increases in the price of silver have correspondingly affected the price of both the hard-copy paper and film supplies for the COMp 80. This fact has made it necessary to reassess the Laboratory's long-term requirements for both plotting and quality text output on equipment of this kind. Various alternates are being considered.

Several new versions of systems software have been put into regular service. These include Release 6 of the Conversational Monitor System (CMS), Edition 7 of the International Mathematical and Statistical Libraries (IMSL), and Release 3.0 of the VS APL language processor. All modifications to the current system software are being made with the new Amdahl computer in mind. The requirement is for a stable and reliable system before the change so that any problems developing afterward can be more easily diagnosed.

**SOLID STATE
DIVISION 8**

INTRODUCTION

This section of the report summarizes progress during the period 1 November 1979 through 31 January 1980. The Solid State Research Report for the same period describes the work of Division 8 in more detail. Funding is primarily provided by the Air Force, with additional support provided by the Army, DARPA, Navy, NASA, NSF, and DOE.

**A. L. McWhorter
Head, Division 8**

**I. Melngailis
Associate Head**

**DIVISION 8 REPORTS
ON ADVANCED ELECTRONIC TECHNOLOGY**

15 November 1979 through 15 February 1980

PUBLISHED REPORTS

Journal Articles

JA No.

4871	MBE Techniques for IV-VI Optoelectronic Devices	H. Holloway* J. N. Walpole	Prog. Cryst. Growth & Charact. <u>2</u> , 49 (1979)
4895	Extended Measurement and Analysis of the ν_3 Infrared Band of Methane	D. L. Gray* A. G. Robiette* A. S. Pine	J. Mol. Spectrosc. <u>77</u> , 440 (1979)
4932	Electron Paramagnetic Resonance in Ferrous Fluosilicate at Submillimeter Wavelengths	R. S. Rubins* H. R. Fetterman	J. Chem. Phys. <u>71</u> , 5163 (1979)
4934	Calculated and Measured Efficiencies of Thin-Film Shallow-Homojunction GaAs Solar Cells on Ge Substrates	J. C. C. Fan C. O. Bozler B. J. Palm	Appl. Phys. Lett. <u>35</u> , 875 (1979)
4935	The Excimer Laser: A New Ultraviolet Source for Medical, Biological, and Chemical Applications	R. M. Osgood, Jr.	In <u>Laser Applications in Medicine and Biology</u> (Plenum Press, New York, 1979)
4960	Efficient Infrared ac Kerr Switches Using Simple Cryogenic Liquids	S. R. J. Brueck H. Kildal	Appl. Phys. Lett. <u>35</u> , 665 (1979)
4973	Tunable Submillimeter Sources Applied to the Excited State Rotational Spectroscopy and Kinetics of CH_3F	W. A. Blumberg H. R. Fetterman D. D. Peck P. F. Goldsmith*	Appl. Phys. Lett. <u>35</u> , 582 (1979)
4978	Subtraction of Signal Overlaps in Rutherford Backscattering Spectrometry	Z. L. Liau	Appl. Phys. Lett. <u>36</u> , 51 (1980)
4986	R-Branch Head of the ν_3 Band of CO_2 at Elevated Temperatures	A. S. Pine G. Guelachvili*	J. Mol. Spectrosc. <u>79</u> , 84 (1980)
4987	Broadly Tunable cw Operation of Ni: MgF_2 and Co: MgF_2 Lasers	P. F. Moulton A. Mooradian	Appl. Phys. Lett. <u>35</u> , 838 (1979)

* Author not at Lincoln Laboratory.

JA No.

5000	Replication of 175 Å Lines and Spaces in PMMA by X-Ray Lithography	D. C. Flanders	Appl. Phys. Lett. <u>36</u> , 1 (1980)
5003	Stimulated Level Shifting and Velocity Inversion in UV-Laser-Excited Photofragments	D. J. Ehrlich R. M. Osgood, Jr.	In <u>Laser Spectroscopy IV</u> , H. Walther and K. W. Rothe, Eds. (Springer-Verlag, Heidelberg, 1979), p. 629
5004	Atomic-Transition Lasers Based on Two-Photon Dissociation of Metal-Triiodide Vapors	T. F. Deutsch D. J. Ehrlich R. M. Osgood, Jr.	Opt. Lett. <u>4</u> , 378 (1979)
5012	High-Speed InP Optoelectronic Switch	F. J. Leonberger P. F. Moulton	Appl. Phys. Lett. <u>35</u> , 712 (1979)
5023	Efficient Shallow-Homojunction GaAs Solar Cells by Molecular Beam Epitaxy	J. C. C. Fan A. R. Calawa R. L. Chapman G. W. Turner	Appl. Phys. Lett. <u>35</u> , 804 (1979)
5028	Interband Magneto-Absorption of $\text{In}_{0.53}\text{Ga}_{0.47}\text{As}$	K. Alavi* R. L. Aggarwal* S. H. Groves	Phys. Rev. B <u>21</u> , 1311 (1980)

Meeting SpeechesMS No.

4949	Effect of Pressure and Composition on Fast Na^+ Ion Transport in the System $\text{Na}_{1+x}\text{Zr}_2\text{Si}_x\text{P}_{3-x}\text{O}_{12}$	J. A. Kafalas R. J. Cava*	In <u>Proceedings of the 1979 International Conference on Fast Ion Transport in Solids</u> (Elsevier North-Holland, New York, 1979), pp. 419, 431, and 479
4986	Crystal Structure and Ionic Conductivity of a New Superionic Conductor, $\text{Na}_3\text{Sc}_2\text{P}_3\text{O}_{12}$	H. Y-P. Hong	
4996	Analysis of the Alternating Current Properties of LISICON Ceramics	M. L. Bayard	
5028	Tunable Transition-Metal-Doped Solid State Lasers	P. F. Moulton A. Mooradian	
5053	Wideband SAW Fourier-Transform-Processor Design and Applications	R. C. Williamson	In <u>Laser Spectroscopy IV</u> , H. Walther and K. W. Rothe, Eds. (Springer-Verlag, Heidelberg, 1979), p. 584
			Case Studies in Advanced Signal Processing (IEE, London, 1979), Vol. 180, pp. 236-243

* Author not at Lincoln Laboratory.

<u>MS No.</u>			
5095	Fabrication of Submicrometer Period Gratings with Precisely Defined Profiles for Integrated Optics Applications	D. C. Flanders A. M. Hawryluk	Integrated and Guided-Wave Optics Technical Digest (January 1980), Session WA3-1
5216	Microfabrication for Guided-Wave Optical Devices	H. I. Smith	Integrated and Guided-Wave Optics Technical Digest (January 1980), Session WA1-1

* * * * *

UNPUBLISHED REPORTS

Journal Articles

<u>JA No.</u>			
5022	Metal-Atom Resonance-Line Lasers	D. J. Ehrlich R. M. Osgood, Jr.	Accepted by IEEE J. Quantum Electron.
5026	Collisional Narrowing of HF Fundamental Band Spectral Lines by Neon and Argon	A. S. Pine	Accepted by J. Mol. Spectrosc.
5033	The Growth of Large, Laser Quality $Nd_xRe_{1-x}P_5O_{14}$ Crystals	R. D. Plattner* W. W. Kruhler* W. K. Zwicker* T. Kovats* S. R. Chinn	Accepted by J. Cryst. Growth
5038	Self-Sustained Pulsations in GaInAsP Diode Lasers	J. N. Walpole T. A. Lind J. J. Hsieh A. G. Foyt	Accepted by Appl. Phys. Lett.
5043	Pump Depletion and Saturation of Two-Photon Resonant Third-Harmonic Generation Processes	H. Kildal S. R. J. Brueck	Accepted by IEEE J. Quantum Electron.
5048	Nonvolatile Analog Memory in MNOS Capacitors	R. S. Withers R. W. Ralston E. Stern	Accepted by IEEE Electron Device Lett.
5050	Remote Sensing of CO Using Frequency-Doubled CO_2 Laser Radiation	D. K. Killinger N. Menyuk W. E. DeFeo	Accepted by Appl. Phys. Lett.
5053	Spectral Intensities of the $4 \mu m v_1 + v_3$ Combination Band of SO_2	A. S. Pine M. Dang-Nhu*	Accepted by J. Mol. Spectrosc.

* Author not at Lincoln Laboratory.

Meeting Speeches*

MS No.

4584B	Schottky Diodes and Their Application to Spectroscopy	H. R. Fetterman	Seminar, Cornell University, Ithaca, New York, 29 January 1980
4779C	Some Recent Developments in Laser Crystallization and Laser Annealing	J. C. C. Fan	Bell Laboratories Seminar, Murray Hill, New Jersey, 4 December 1979
4946B	Fabrication and Applications of Artificial Microstructures	H. I. Smith	Sigma Xi Mtg., Waltham, Massachusetts, 15 November 1979
4946C	Fabrication and Applications of Artificial Microstructures	H. I. Smith	Raytheon Research Seminar, Waltham, Massachusetts, 7 November 1979
4960A	Development and Applications of High-Speed InP Optoelectronic Switches	F. J. Leonberger P. F. Moulton	Topical Mtg. on Integrated and Guided-Wave Optics, Incline Village, Nevada, 28-30 January 1980
5204	Oxide-Confining GaAs Optical Waveguides Formed by Lateral Epitaxial Growth	F. J. Leonberger C. O. Bozler R. W. McClelland I. Melngailis	
5007A	Submillimeter Model Measurements and Their Applications to Millimeter Radar Systems	J. Waldman H. R. Fetterman P. E. Duffy T. G. Bryant P. E. Tannenwald	4th Intl. Conf. on Infrared and Millimeter Waves and Their Applications, Miami, Florida, 10-15 December 1979
5164	Integrated Monolithic Mixers on GaAs for Millimeter and Submillimeter Wave Applications	B. J. Clifton R. A. Murphy G. D. Alley	
5165	Performance of Cooled Corner Reflector Schottky Diode Receiver between 1 mm and 118 μ m	H. R. Fetterman P. F. Goldsmith† B. J. Clifton C. D. Parker P. E. Tannenwald	
5202	Monolithic Silicon Bolometers	P. M. Downey† R. Weiss† F. J. Bachner J. P. Donnelly W. T. Lindley R. W. Mountain D. J. Silversmith	

* Titles of Meeting Speeches are listed for information only. No copies are available for distribution.

† Author not at Lincoln Laboratory.

<u>MS No.</u>			
5028A	Tunable Transition-Metal Doped Solid State Lasers	A. Mooradian	10th Winter Colloquium on Quantum Electronics, Snowbird, Utah, 14-17 January 1980
5235	Laser-Induced Deposition at Material Surfaces	D. J. Ehrlich T. F. Deutsch R. M. Osgood, Jr.	
5044A	1.0-1.6 μ m Sources and Detectors for Fiber Optics Applications	A. G. Foyt	Intl. Conf. on Lasers '79, Orlando, Florida, 17-21 December 1979
5153	Recent Developments in Solid State Laser Materials	W. K. Zwicker* S. R. Chinn	
5107	Crystallographic and Electrical Properties of Silicon Produced by Graphoepitaxy	M. W. Geis D. Antoniadis D. C. Flanders H. I. Smith	
5152	Laser-Induced Photochemical Reactions for Electronic Device Fabrication	D. J. Ehrlich T. F. Deutsch R. M. Osgood, Jr.	
5154	Fabrication of Ohmic Contacts on p-Type InP Using Ion-Implantation and Laser Annealing	Z. L. Liau N. L. DeMeo J. P. Donnelly D. E. Mull R. Bradbury* J. P. Lorenzo*	Materials Research Society Symp., Cambridge, Massachusetts, 26-30 November 1979
5157	Solid-Phase Crystallization Produced by Laser Scanning of Amorphous Ge Films: The Role of Latent Heat in Crystallization Front Dynamics	H. J. Zeiger J. C. C. Fan R. P. Gale R. L. Chapman	
5107A	Crystalline Silicon on Insulators by Graphoepitaxy	M. W. Geis D. C. Flanders D. A. Antoniadis H. I. Smith	
5205	A 2-Phase GaAs Schottky Barrier CCD	G. L. Hansell W. T. Lindley A. L. McWhorter A. Chu	IEDM, Washington, D.C., 3-5 December 1979
5107C	Crystallographic Orientation of Silicon on Amorphous Substrates by Graphoepitaxy	M. W. Geis D. C. Flanders D. A. Antoniadis H. I. Smith	ILO Symp. on Solar Energy, M.I.T., 4 December 1979
5124	Proposed Design of a-Si:H Solar Cells Using Ultrathin Active Layers to Increase Conversion Efficiency	J. C. C. Fan C. O. Bozler	14th IEEE Photovoltaic Specialists Conf., San Diego, California, 7-10 January 1980

* Author not at Lincoln Laboratory.

<u>MS No.</u>			
5127	GaAs Shallow-Homojunction Solar Cells	J. C. C. Fan G. W. Turner R. P. Gale C. O. Bozler	
5128	Indium Phosphide Homojunction Solar Cells	G. W. Turner J. C. C. Fan J. J. Hsieh	14th IEEE Photovoltaic Specialists Conf., San Diego, California, 7-10 January 1980
5129	Efficient Large-Grained GaAs Homojunction Solar Cells	G. W. Turner J. C. C. Fan R. P. Gale O. Hurtado	
5130	A New Technique for Producing Large-Grained Semiconductor Sheets by Scanned Laser Crystallization of Amorphous Films	J. C. C. Fan H. J. Zeiger R. P. Gale R. L. Chapman	
5161A	Recent Results with the Permeable Base Transistor	C. O. Bozler G. D. Alley R. A. Murphy D. C. Flanders W. T. Lindley	Conf. on Advanced Research in Integrated Circuits, M.I.T., 28-30 January 1980
5247	Artificial Microstructures Research and Its Impact on Future Integrated Electronics	H. I. Smith	
5169	Redistribution of Implanted Zn in InP after Q-Switched Laser Annealing and Related Specific Contact Resistance	Z. L. Liau N. L. DeMeo J. P. Donnelly J. V. Norberg* V. R. DeLine* C. A. Evans * J. P. Lorenzo	Symp. on Laser and Electron Beam Processing of Materials, Cambridge, Massachusetts, 27-30 November 1979
5249	Microlithography and New Materials for VLSI	H. I. Smith	Workshop on Microprocessors in Military and Industrial Systems, Johns Hopkins University, Laurel, Maryland, 15-16 January 1980

* Author not at Lincoln Laboratory.

SOLID STATE
DIVISION 8

I. SOLID STATE DEVICE RESEARCH

Substantial reduction in the surface component of the dark current in GaInAsP/InP avalanche photodiodes has been achieved by the application of new surface passivation techniques. Leakage current densities as low as 4×10^{-6} A/cm² at half the breakdown voltage have been achieved.

CW operation at temperatures up to 55°C has been achieved for GaInAsP/InP double-heterostructure (DH) lasers emitting at 1.5 μm, which were grown without a GaInAsP buffer layer. These devices are of interest for use as sources in fiber optics communications systems, since the lowest transmission loss reported for fused-silica optical fibers occurs at 1.55 μm.

The electrical characteristics of InP ion implanted with Sn, Ge, Si, and C have been investigated. All of these column-IV elements yielded n-type conductivity and Sn, Ge, and Si showed high electrical activation; however, implanted C was found to have a net electrical activation of only about 5 percent.

The growth-temperature dependence of the GaInAsP/InP lattice mismatch has been measured over a wide range of quaternary compositions. Smooth GaInAsP layers have grown directly on InP substrates without an InP buffer layer; however, the use of an InP layer results in a smooth GaInAsP/InP interface, which is needed for DH lasers.

II. QUANTUM ELECTRONICS

Fluorescence lifetime and fluorescence spectra have been studied for several transition metal systems in which laser action either has been obtained or may be possible. The results of lifetime vs temperature measurements indicate the potential for room-temperature laser operation in Ni:CaY₂Mg₂Ge₃O₁₂ (CAMGAR) and the limitation of lasing in V:MgF₂ to below 200 K.

Schottky diode mixer operation has been demonstrated at 30-THz carrier frequencies. Using isotopic CO₂ lasers, beats were observed to 15.6 GHz. Experiments are under way at higher frequencies which should further clarify the mixing mechanism.

III. MATERIALS RESEARCH

Conversion efficiencies exceeding 13 percent at AM1 and open-circuit voltages approaching 0.9 V have been achieved for GaAs homojunction solar cells grown by chemical vapor deposition on large-grained GaAs substrates. These values, the highest so far reported for polycrystalline GaAs cells, were obtained by using a new passivation method that involves electroplating Sn on the GaAs surface and subsequent heat treatment.

Homojunction InP solar cells with conversion efficiencies up to 15 percent at AM1, the highest values reported for InP cells of any type, have been fabricated on single-crystal InP substrates. The cells incorporate an n⁺/p/p⁺ structure prepared by liquid-phase epitaxy and an antireflection coating formed by anodic oxidation of the n⁺ surface.

With the objective of developing a method for preparing low-cost Ge substrates for GaAs solar cells, an optical transmission technique has been used to measure the crystallization front velocity during scanned laser crystallization of amorphous Ge films. The measured velocities range from 146 to 260 cm/sec, compared with the laser scanning velocity of 0.5 cm/sec.

IV. MICROELECTRONICS

Quantitative measurements have been made of the orientation, texture, and sheet resistivity of silicon films grown by graphoepitaxy on fused-silica substrates. On 3.8- μm spatial-period surface gratings the [100] directions are parallel to the grating to within $\pm 1.5^\circ$ and perpendicular to the substrate surface to within $\pm 1.5^\circ$. The sheet resistivity of silicon films 0.5- μm thick doped with phosphorus was 2.5 times larger than that measured for silicon wafers with similar doping used for controls.

The mixing action in a SAW accumulating correlator with CCD readout has been determined to occur in the varactor-like nonlinearity of the drain region of the sampling-finger bias transistors. The accumulation of the mixing product takes place in an RC integrator formed by the resistance of the nearly pinched-off transfer channel and the capacitance of the CCD ϕ_1 well.

A multiplying digital-to-analog converter of novel design, which uses capacitance-weighted CCD inputs, has been implemented using buried-channel CCD techniques. The device has been used to D/A convert 8-bit words at a 10-MHz digital-word data rate. The device can be integrated on-chip with CCD signal-processing devices and will accept digital inputs directly from a TTL source with no TTL-to-MOS buffer.

Two-phase GaAs CCDs have been fabricated which utilize an etched step to create the necessary potential barrier under each gate. Shadow evaporation is used to form submicrometer gaps between the electrodes without photolithography. The CCDs exhibited 0.993 transfer efficiencies with uniphase clocking at frequencies up to 10 MHz.

The underlying physical events which govern transport properties in devices operated at high frequencies or with submicrometer dimensions have been identified and formulated for use in device modeling. For devices where the basic frequency limitations are RC in nature, a high mobility and hence long momentum-relaxation time is required. However, in transferred electron and IMPATT devices the high-frequency performance will be enhanced when the energy relaxation time is short, which implies lower mobility.

V. ANALOG DEVICE TECHNOLOGY

A satellite-borne chirp-Fourier-transform system for efficient demodulation of frequency-shift-keyed uplink signals has been developed. This system exploits the capabilities of four SAW reflective-array compressors to implement a pair of convolve-multiply-convolve chirp-transform circuits which are compact and low-power. The system allows the continuous demodulation of high-data-rate communications from 100 simultaneous users with a minimum of intersymbol interference.

The performance of gap-coupled acoustoelectric convolvers has been extended to 200-MHz bandwidth and 2400 time-bandwidth product. This structure is very rugged, as has recently been demonstrated by an extensive series of shock and vibration tests. Projections are made of the limits to which matched filter performance may be extended with this convolver technology.

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number) <p style="text-align: center;">This Quarterly Technical Summary covers the period 1 November 1979 through 31 January 1980. It consolidates the reports of Division 2 (Data Systems) and Division 8 (Solid State) on the Advanced Electronic Technology Program.</p>														

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